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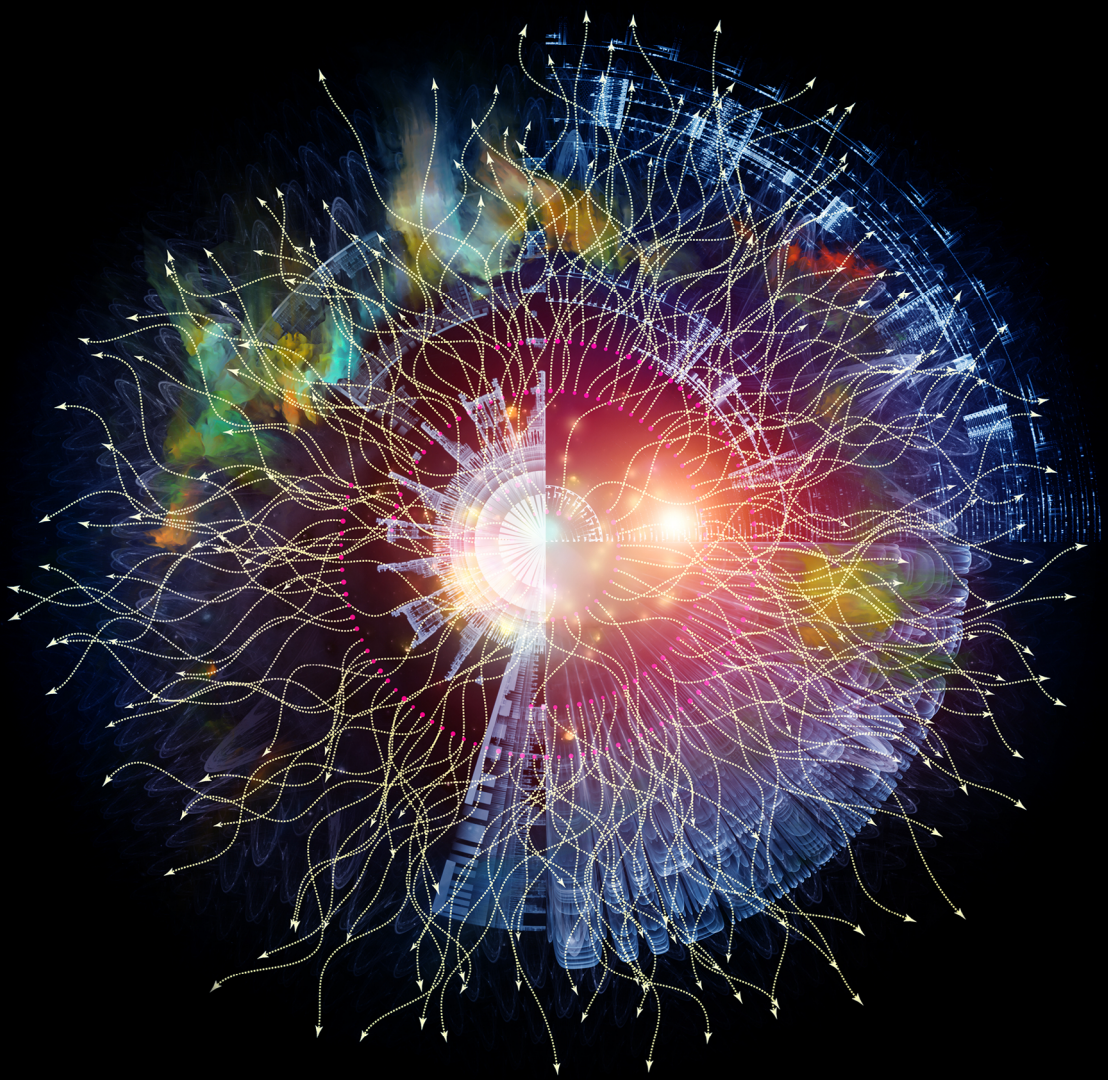

Predictive Maintenance for Logistics Equipments with D.PRIM

Using SAP & Google Cloud Platform

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Introduction

In the fourth industrial revolution, a.k.a. Industry 4.0, production sites, mechanized warehouses and other facilities are investing in high-cost machinery, automation and robotics across the supply chain to stay competitive in the market, increase throughput and meet fast-changing customer demands. Companies are adapting to and using these high-tech solutions to increase efficiency and productivity while reducing labor costs. At the same time, they have to put in extra effort to keep up with quality control, prevent equipment failures and potential downtime, and comply with safety and regulatory requirements. The best way to overcome these challenges is to establish a maintenance strategy tailored to your operations. Choosing the right maintenance process can prolong the lifespan of the assets, ensure the quality of the products, reduce both errors and breakdown risks and prevent disruption to the operations.

Overall Equipment Efficiency (OEE) is a useful metric to track the efficiency and effectiveness of equipment used in the manufacturing and logistics process. As a key performance indicator (KPI), OEE provides an overview of the *availability, performance and quality* of a particular machine or device, playing a crucial role in the continuous improvement of supply chain operations (e.g., manufacturing and warehouse processes). The OEE score will vary based on the maintenance strategy that a customer chooses.

The graphic below describes key maintenance strategies.

Predictive Maintenance

Why predictive maintenance over other maintenance strategies?

Basic principles of predictive maintenance
Predictive maintenance is a strategy that allows users to detect equipment malfunctions at an early stage and prevent the situation from deteriorating as well as the need for repairs at an early stage. At the most basic level, this system entails installing sensors on different machine parts and using software to monitor performance at different levels of hierarchy (machine parts, entire machines, networked machines).

Predictive maintenance plays an integral role in Industry 4.0, with the data collected by the sensors as the most important leverage. Data is collected, stored, and analyzed to make accurate and reliable predictions for the need of maintenance. As data is processed in near real-time, data-driven forecasts for maintenance tend to be more precise and faster. The system also gathers accurate information about the machine's condition to ensure maintenance tasks are performed only when necessary. We call this maintenance strategy "Maintenance 4.0", and it includes a comprehensive overview of data sources, different methods of collecting, analyzing and visualizing the data, and, if necessary, recommendations on how to optimize an asset's performance.

Benefits of predictive maintenance
Predictive maintenance provides the following **core benefits:**

Competitive advantages
Manufacturers that recognize the value of predictive maintenance can make better use of their equipment and available resources, which means better quality products and services for their customers. Customer satisfaction and the company's market position will improve as a result.

Higher product quality
With the ability to detect deviations from normal equipment condition at an early stage, manufacturers can produce exclusively within agreed tolerances and deliver consistently high product quality.

Lower maintenance costs
With the help of real-time machine data, predictive maintenance allows users to plan maintenance work more precisely and reduce costs by minimizing the amount of unnecessary maintenance and using resources more efficiently.

Higher equipment availability
In addition to reducing costs, users can increase machine run time and overall productivity rates if they detect problems early and keep a more precise maintenance schedule.

Solution approach

SAP & Google Cloud platform integration

Combining SAP and Google Cloud's data and analytics technology makes enterprise data more transparent and valuable, while also advancing enterprise AI development. The mission critical datasphere from SAP and non-SAP sources on Google Cloud is helping our clients accelerate their digital transformation. Thanks to this integration, they can *access business-critical data in real time, simplify their data landscape, create trusted insights with Google Cloud's advanced AI and machine learning (ML) models, perform advanced analysis and utilize joint solutions for sustainability.*

Google Cloud Deloitte. SAP

Solution design:

There are four key phases in the solution design for predictive maintenance: **sense, predict, act and report and monitor.**

Sense

Connected Assets

- Onboarding & Connectivity
- Security

Predict

Data & Analytics

- Data Ingestion & Curation
- Real time feed to detect trends and Anomalies
- Machine Learning models for Anomaly detection
- Triggering of corrective actions

Act

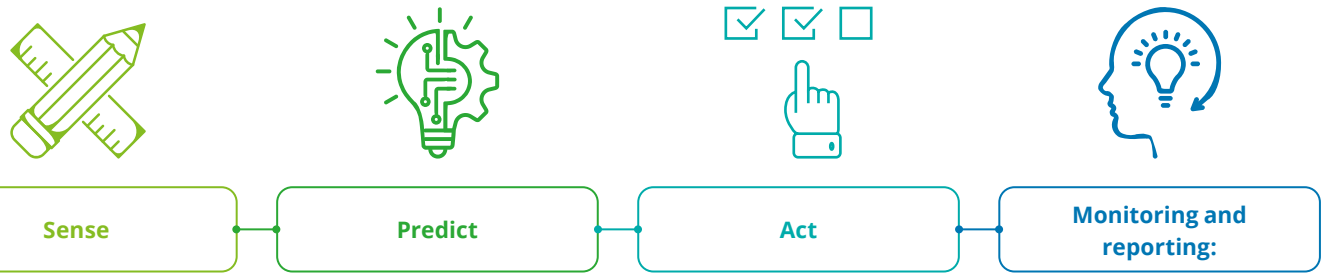
Maintenance activities

- Prioritized maintenance and service activities
- Optimized warranty and spare parts management
- Quality improvements

Report

Insights

- Root cause analysis
- Asset Health Monitoring
- Asset Utilization
- Incidents reporting



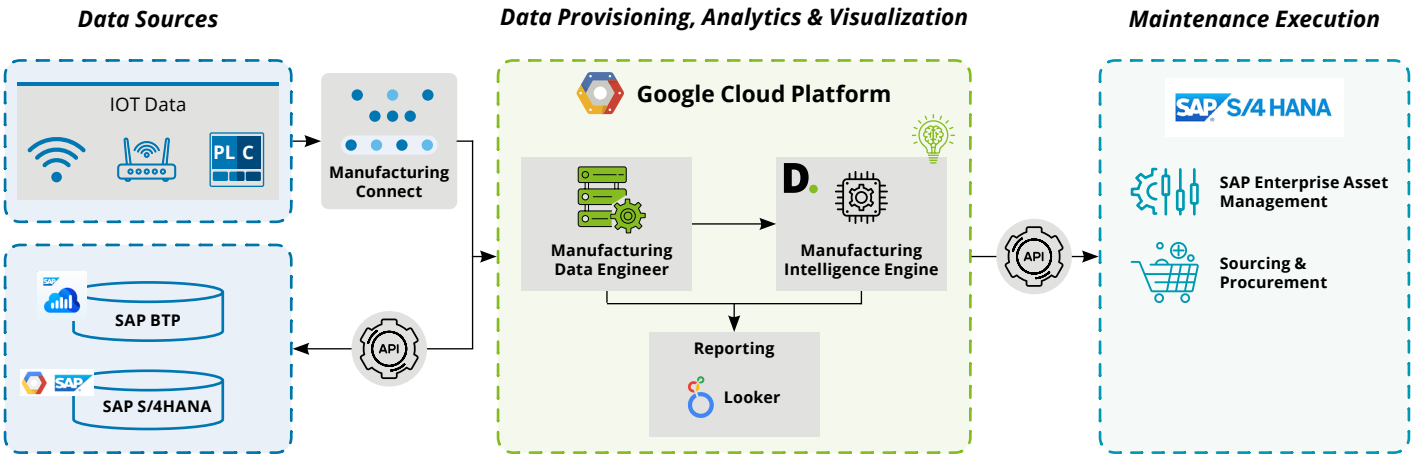
This phase deals with the detection and ingestion of machine signals and their subsequent integration into the computation pipeline. Machines sensors operate on protocols, almost all of them being supported by Manufacturing Connect (MC) Edge. Manufacturing Connect is an Edge data management platform which manages and enriches machine data into a digestible format; hence acting as an entry point into the cloud. Available machine parameters like temperature, vibration, pressure etc. are translated and digested to be passed on to Manufacturing Data Engine (MDE) for contextualization, storage, and prediction.

Anomaly detection takes place in a data engine that combines Google Cloud's Manufacturing Data Engine (MDE) with an intelligence engine using GCP-native query and AI features. The system trains the model to detect patterns within the ingested data, using thresholds in temperature, pressure and other parameters to identify deviations from the norm.

Any anomalies detected in the previous phase trigger the required maintenance tasks in the SAP S/4 system. This includes a web service call from GCP MDE and a notification document generated in SAP Enterprise Asset Management (EAM), which includes the information needed to create maintenance orders for subsequent process steps and to initiate the technicians' repair tasks. The predictions based on the evaluations enable optimum maintenance.

Finally, the GCP native tool Looker is used for visualization and reporting purposes. The tool draws on all the data ingested and enriched so far to issue reports tailored to the specific use case or requirements. Thanks to its deep integration with GCP services as well as its versatility and flexibility with other data objects, Looker is a great choice as a visualization platform. It allows you to track asset health with highly configurable charts, tables and reports using different parameters. It can also monitor asset utilization on the basis of time series data as well as curating alerts and issuing incident reports.

Solution architecture



The solution architecture includes any piece of equipment that can deliver real-time data, whether it is IoT, operational and transactional data. The IoT data gathered from programmable logic controllers (PLCs) and the operational data collected in the MES are passed on to the Manufacturing Connect (MC) platform for contextualization. Though there are different levels of integration, e.g., equipment-level data (from IoT and sensors), process-level data or even business operations-level (from SAP S/4HANA), the Google MDE stages and integrates data on the cloud platform to detect patterns and anomalies. A data engine API (Google MDE using AI features) fetches this enriched data using BigQuery. At the same time, SAP-native services leverage the transactional data (from SAP S/4HANA) and couple this intermediate data with MDE data to execute the maintenance tasks in SAP S/4HANA (EAM) and visualize them in GCP Looker.

Benefits of this architecture:

Collecting and leveraging industrial data has always been a time-consuming, complex and costly process. Thanks to MDE, users have a scalable and flexible end-to-end solution that ingests, processes, stores and analyzes data from industrial devices. This combined with transactional data contextualized in SAP forms the basis for AI/ML applications in the cloud and maintenance tasks assigned via SAP. We designed this architecture as an easy-to-use and implement solution in a pre-configured, zero-code environment in Google Cloud. The components of the architecture are designed to work seamlessly with each other and share the same set of configurations. You can also define custom specifications for data without changing the underlying code using either the MC user interface or the MDE configuration API.

Why Deloitte

Deloitte's alliance with SAP and Google keeps going from strength to strength. To name just a few of the 2023 highlights, we won three SAP Pinnacle Awards in the categories Delivery Quality, Cloud Business Transformation (Delivery Quality) and Cloud Business Transformation with SAP S/4 Cloud, public edition, while Google announced Deloitte as their 2023 Partner of the Year. Our worldwide network of subject matter experts offers a wide range of services in and around both SAP and Google Cloud Platform. By leveraging leading industry practices, championing cutting-edge capabilities and drawing on lessons learned from prior transformations, Deloitte delivers tailored solutions to meet individual customer needs. Our innovation program has completed several joint flagship projects with SAP and Google Cloud in generative AI. Building innovative solutions that combine the best of these two powerful technologies helps businesses make the most of their enterprise data and accelerate their digital transformation journey.

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Glossary

EAM	– Enterprise Asset Management
GCP	– Google Cloud Platform
MC	– Manufacturing Connect
MDE	– Manufacturing Data Engine
ML	– Machine learning
OEE	– Overall equipment efficiency
API	– Application programming interface

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